

Transparent Thermoplastic Acrylic Scintillator

JUI-JEN (Ryan) Wang
University of Michigan

CPAD Instrumentation Frontier Workshop 2021



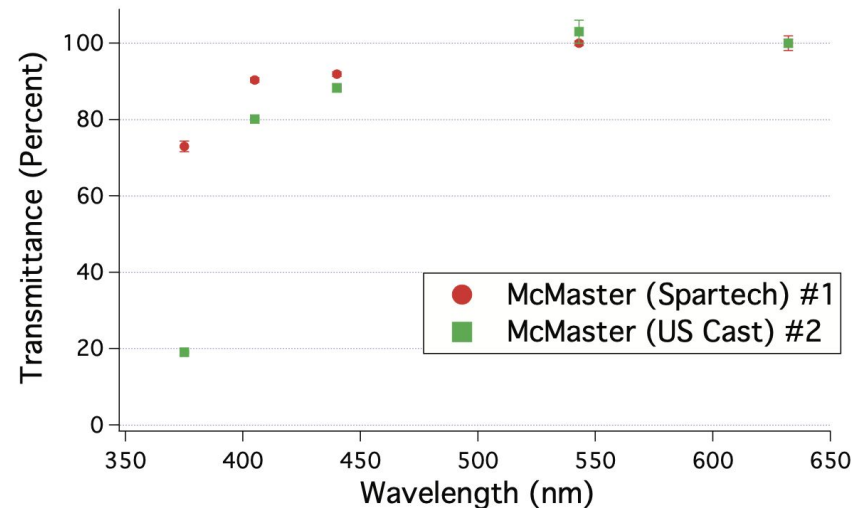
- Acrylic scintillator
 - Properties
- Outlook of properties measurement
 - Characterization
 - Performance
- Potential applications
 - Applications in various fields
- Summary

- vs. Liquid scintillator
 - Less prone to aging
 - Good long term stability
 - Mechanically strong and inexpensive
 - Suitable for large scale detector
- vs. Plastic scintillator
 - Cheaper
 - Additional PSD power
- Highly transparent to UV and visible light
- Good endurance to environmental impact
 - Such as moisture and temperature
 - Vacuum system
- Good neutron moderator



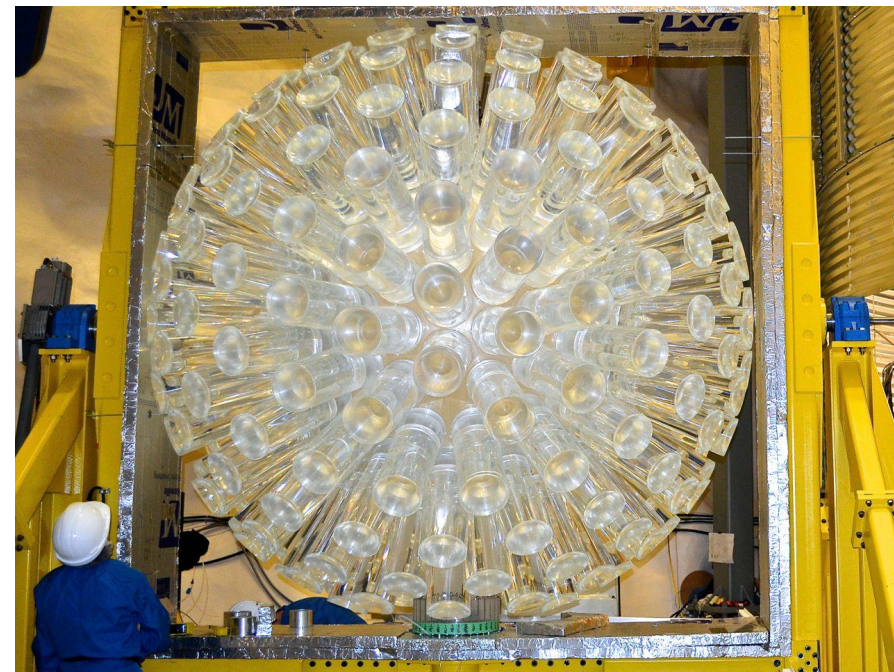
No doped, commercial acrylic with TPB coating from MiniCLEAN

- Commercially available acrylic has attenuation length around 7 m in visible range
- Doped with LS and fluor reduce the attenuation length
 - Optimize the cocktail to maximize the attenuation length
- Multiple layers acrylic detector
 - Doped with different rare-earth element to achieve shielding of different particle
 - Along with SiPM to maximize the light collection efficiency



<https://doi.org/10.1088/1748-0221/9/02/P02002>

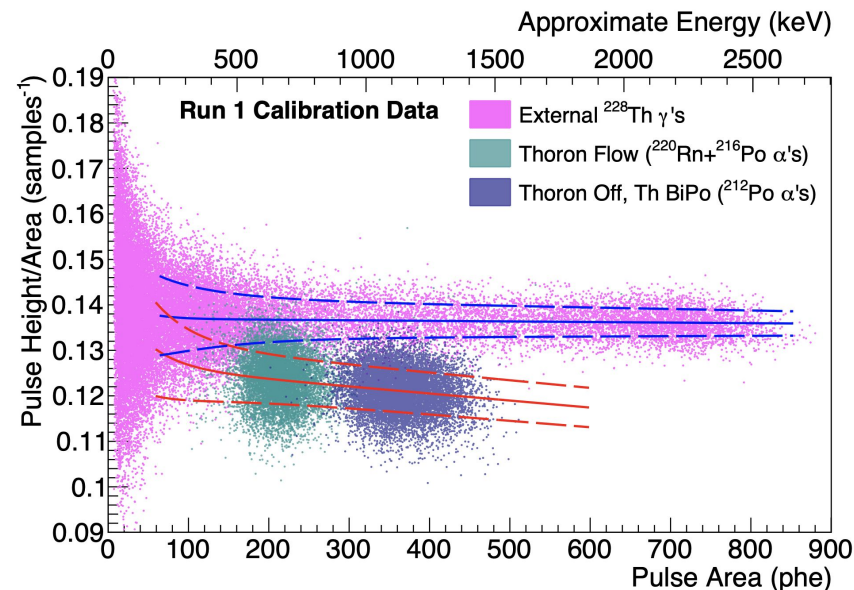
- Can be produced in a radiopure fashion
 - Also serve as neutron moderator
 - Demonstrated by DEAP-3600 as a vessel of liquid argon
- Radiopurity is comparable to the PTFE
 - Screener developed by LZ collaboration exhibit the radiopurity of the GdLS
 - Produce in the radon controlled environment to reduce the Rn-daughter plater out



DEAP-3600



- Light yield is comparable to plastic scintillator
 - Offer an opportunity to optimize the light yield.
- LS exhibit the pulse shape discrimination (PSD) capability
 - Tagging the alpha particle help to understand the internal background and neutrons produced from alpha-n reaction
 - PSD power depends on the detail composition of the fluors, further study is in need to optimize the performance.



<https://arxiv.org/pdf/1808.05595.pdf>

- Particle physics
 - Neutrino experiment
 - Constructing vessel with acrylic scintillator
 - Dark matter experiment
 - Serve as active outer detector
 - Collider experiment
 - Replace plastic scintillator for muon tracking
- Border control
 - Suitable for constructing detector in any shapes
 - Doping with high-Z material for gamma detection
- Medical physics
 - Measuring dose in external beam radiotherapy



- Principle of LS-based acrylic scintillator is proven at 10% of loading
 - PPO and bis-MSB as fluors
 - Continuing formula optimization to improve
 - Light-yield using higher LS loading or mixture of LS with conventional plastic resins (e.g. PVT, PS) in acrylic
- Goal to produce Gd/Pb doped acrylic scintillator
- More characterizations are coming after COVID!

